Module descriptions for the degree program

Information Systems
Master of Science (M.Sc.)

Technische Hochschule Ulm
University of Applied Sciences

vom 01.06.2019
(gültig ab 09/2019)

Content

Module abbreviation SDR	**ECTS** 9	**Language** English	**Semester** 1st	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☐ Winter semester

Module title
Software Design and Implementation *(Software Design und Realisierung)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Assigned classes
Model-Driven Development of Complex Systems, Software Quality Assurance

Module responsibility	**Teaching staff**
Prof. Dr. C. Schlegel	Prof. Dr. P. Graf, Prof. Dr. G. Schied, Prof. Dr. C. Schlegel

Classification and significance of the module, in relation to the aims of the degree program
Basic module on software methods and software tools for the realization and quality assurance of complex information systems, with a focus on model-driven approaches. This takes the development into account that, in computer science, methods and tools for concept abstraction are playing an ever-greater role in the management of complexity.

Learning outcomes
After the module has finished, the students will be able to

Subject competence
- apply the concepts and methods of model-driven software development and software quality assurance
- adapt an example toolchain from modeling to code generation
- adequately estimate the measures required to achieve the quality goals and to use the associated tools appropriately.

Method competence
- discuss the subject knowledge using practical problems, analyze problems and synthesize their own solution approaches
- use and adapt product and process-oriented software quality assurance methods

Social and personal competence
- appreciate the significance of model-based software development and competently represent its issues
- appreciate the significance of systematic quality assurance for the success of the project, and to competently represent quality assurance concerns in a project environment.

Content
- Concepts, methods and tools of model-driven software development
- Software quality assurance concepts, methods and tools

Literature references

- Open Model CourseWare (OMCW), Eclipse Modeling Project, http://www.eclipse.org/gmt/omcw/resources/
- M. Fowler: Domain-Specific Languages, Addison Wesley, 2011, ISBN 0-321-71294-3
- R. C. Gronback: eclipse Modeling Project: A Domain-Specific Language (DSL) Toolkit, Addison-Wesley, 2009, ISBN 0-321-53407-7
- T. Stahl, M. Völter, S. Efftinge, A. Haase: Modellgetriebene Softwareentwicklung, 2. Auflage, dpunkt Verlag, 2007, ISBN 3-89864-448-0
- P. Liggesmeyer: Software-Qualität. 2. Aufl., Spektrum Akademischer Verlag, 2009
- D.W. Hoffmann: Software-Qualität. Springer, 2008
- M. Utting: Practical Model-Based Testing. Morgan Kaufmann, 2007
- D.A. Peled: Software Reliability Methods. Springer, 2001
- F. Nielson, H.R. Nielson, Ch. Hankin: Principles of Program Analysis. Springer, 1999
- B. Berard u.a.: Systems and Software Verification – Model-Checking Techniques and Tools. Springer 2001
- M.B. Chrissis, M. Konrad, S. Shrum: CMMI for Development: Guidelines for Process Integration and Product Improvement.3rd ed., Addison-Wesley Longman, 2011

Other literature may be specified as part of the currently relevant course

Form of academic assessment	Oral examination		**Monitored assignment**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	90 h	180 h	0 h	270 h

Classes	SWS	ECTS	Teaching and learning form
Model-Driven Development of Complex Systems	4	6	Lectures (3 SWS), Lab work (1 SWS)
Software Quality Assurance	2	3	Lectures with integrated exercises (2 SWS)

Document version	0.2	Created	by CHS on 19.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
MDCS	6	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Model-Driven Development of Complex Systems *(Modellgetriebene Entwicklung komplexer Systeme)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Responsible for content	Teaching staff
Prof. Dr. C. Schlegel	Prof. Dr. P. Graf, Prof. Dr. C. Schlegel

Classification and significance of the course, in relation to the aims of the degree program Model-driven software development (MDSE, MDSD) concerns the development of software systems as a consequence of systematic transformations of models, thereby raising software development concepts to a higher level of abstraction, more independent of implementation. A model-driven approach is playing an ever-greater role in the management of complexity (separation of roles, separation of concerns) in modern computer systems.

Learning outcomes
After the classes have finished, the students will be able to
Subject competence
- use the concepts and methods of model-driven software development
- adapt an example toolchain from modeling to code generation

Method competence
- discuss the subject knowledge using practical problems, analyze problems and synthesize their own solution approaches

Social and personal competence
- appreciate the significance of model-based software development and competently represent its issues

Content
Firstly, model-driven software development (MDSD) concerns the increase of efficiency by means of automation and reuse. Here, infrastructure code, subsystems, configurations or entire applications are generated from models, which represent the relevant properties independently of implementation. Secondly, it offers approaches for managing complexity in the development, manufacture and maintenance of large software systems, by separating roles and aspects. The lectures cover concepts, methods and tools for model-driven software development.
- Focus on models as primary development artefacts
- Modeling languages (e.g. Ecore, OCL), meta-modeling, development of needs-based meta-models, domain specific languages (DSL), UML profiles
- Transformations (M2M, e.g. ATL), code generation (M2T, e.g. Xpand)
- Systematic implementation in tools (e.g. Eclipse Modeling Project, plugins, Xtext)
- Current topics (e.g. model-versioning, maintenance and further development of (meta) models)
- Realization of a continuous example by using MDSD in teams

Literature references
- Open Model CourseWare (OMCW), Eclipse Modeling Project, http://www.eclipse.org/gmt/omcw/resources/
- M. Fowler: Domain-Specific Languages, Addison Wesley, 2011, ISBN 0-321-71294-3
- R. C. Gronback: eclipse Modeling Project: A Domain-Specific Language (DSL) Toolkit, Addison-Wesley, 2009, ISBN 0-321-53407-7
- T. Stahl, M. Völter, S. Efftinge, A. Haase: Modellgetriebene Softwareentwicklung, 2. Auflage, dpunkt Verlag, 2007, ISBN 3-89864-448-0
Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (1 SWS)		
Form of academic assessment		**Monitored assignments**	none
Prerequisite course			

Course scope	Time present	Self-study	Practical time	Total time
	60 h	120 h	0 h	180 h

Document version	0.1	Created	by CHS on 19.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
SWQS	3	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Software Quality Assurance *(Software-Qualitätssicherung)*

Assigned to curriculum
Master Information Systems (1st sem.)

Responsible for content	Teaching staff
Prof. Dr. G. Schied	Prof. Dr. G. Schied

Classification and significance of the course, in relation to the aims of the degree program
Quality assurance is an important cross-functional activity in the development of complex information systems. Initially, this class offers an overview of the different areas of software quality assurance, then selected current topics will be examined in greater detail. Focus topics are the use of formal and model-based methods.

Learning outcomes

Subject competence
- The students understand which features are associated with software quality and have an overview of which measures can be used to achieve quality targets.
- They understand the procedures, modeling techniques and tools for model-based testing and can assess their applicability for specific testing tasks.
- They understand the fundamental methods for automated program analysis and formal correctness verification and can assess their applicability.

Method competence
- They can apply systematic testing techniques and tools for black-box and white-box tests
- They can apply and adapt formal and model-based methods and tools, in order to demonstrate formally specified properties of systems by testing, automated static analysis or verification.

Social and personal competence
- The students have developed an awareness regarding the significance systematic quality assurance has for the success of a project, and can competently represent quality assurance concerns in a project environment.

Content
- Basics: relevance of software quality assurance, product and process quality, analytical and constructive activities for quality assurance
- Inspections and reviews
- Conventional testing techniques: testing process, equivalence-class analysis, state-based testing, structural testing techniques, test automation
- Model-based testing: model-based testing process, modeling techniques, algorithms and tools for generating test cases
- Automated static program analysis: syntax-oriented checking, basic principles and applications of control flow and dataflow analysis
- Formal verification techniques: formal program verification, model checking

Literature references
- D.W. Hoffmann: Software-Qualität. Springer, 2. Aufl., 2013
- J. Tian: Software Quality Engineering, Wiley-IEEE Computer Society Press, 2005
- P. Liggesmeyer: Software-Qualität. 2. Aufl., Spektrum Akademischer Verlag, 2009
- M. Utting: Practical Model-Based Testing. Morgan Kaufmann, 2007
- T. Roßner u.a.: Basiswissen Modellbasierter Test, dpunkt.verlag, 2010
- B. Berard u.a.: Systems and Software Verification – Model-Checking Techniques and Tools. Springer 2001

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures with integrated exercises (2 SWS)		
Form of academic assessment		**Monitored assignments**	none

Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.4	**Updated**	by GS on 26.04.2019

Module abbreviation IIS	**ECTS** 9	**Language** English	**Semester** 1st	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☐ Winter semester

Module title
Intelligent Information Systems *(Intelligente Informationssysteme)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Assigned classes
Intelligent and Cognitive Systems, Autonomous Systems

Module responsibility	**Teaching staff**
Prof. Dr. R. Lunde	Prof. Dr. R. Lunde, Prof. Dr. C. Schlegel

Classification and significance of the module, in relation to the aims of the degree program
Profile-forming module for exploring the field of intelligent systems. Adaptability and the ability to make decisions are key properties of future intelligent information systems. This requires – also due to the increasing complexity of information systems – the realization of individual components as autonomous systems; which are equipped with a higher degree of freedom to make decisions. The increasing interlinking of mobility with perception, reasoning and action generation results in information systems with complex cognitive abilities and multi-modal possibilities for interaction.

Learning outcomes
After successfully completing the module, students will be able to

Subject competence
- describe the strengths and weaknesses of different artificial intelligence (AI) methods, to estimate and evaluate their practical applicability for a specific problem, as well as applying and extending them for the realization of intelligent information systems
- classify and apply methods for dealing with uncertain information (situational and environmental modeling, location information, reasoning, data fusion) in real-world scenarios

Method competence
- analyze and model difficult-to-structure problems, and to make efficient AI solution approaches accessible and implement them technically
- analyze and model complex problems regarding uncertain information and to make efficient solution approaches accessible

Social and personal competence
- recognize and evaluate the limits and risks of implementing these methods in practice
- reflect upon and question the fundamental mechanisms of our own thoughts and actions
- discuss fundamental views of the question: what connects and separates human and machine problem solvers/human and machine autonomy

Content
- Artificial intelligence methods and algorithms
- Advanced algorithms and methods for dealing with uncertain information
- Realization of cognitive architectures and autonomous systems

Literature references

- Russell, S.; Norvig, P.: Artificial Intelligence – A Modern Approach (Third Edition), Prentice Hall 2010, ISBN-13 978-0136042594
- Beierle, C.; Kern-Isberner, G.: Methoden wissensbasierter Systeme, Vieweg 2006, ISBN-13 978-3834800107
- S. Thrun, W. Burgard, D. Fox: Probabilistic Robotics, MIT Press, 2005, ISBN 0-262-20162-3
- R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza: Introduction to Autonomous Mobile Robots, 2nd Edition, Intelligent Robotics and Autonomous Agents series, MIT Press, 2011, ISBN 0-262-01535-8
- D. L. Hall, J. Llinas: Handbook of multisensory data fusion, CRC Press, 2001, ISBN 0-8493-2379-7
- D. Brugali: Software Engineering for Experimental Robotics, STAR series, volume 30, Springer, 2007, ISBN 3-540-68949-4

Other literature may be specified as part of the currently relevant course

Form of academic assessment	Oral examination		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	90 h	180 h	0 h	270 h

Classes	SWS	ECTS	Teaching and learning form
Intelligent and Cognitive Systems	4	6	Lectures (3 SWS), Lab work (1 SWS)
Autonomous Systems	2	3	Lectures (1 SWS), Lab work (1 SWS)

Document version	0.3	Created	by CHS on 18.08.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
IKS	6	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Intelligent and Cognitive Systems *(Intelligente und kognitive Systeme)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Responsible for content	Teaching staff
Prof. Dr. R. Lunde	Prof. Dr. R. Lunde

Classification and significance of the course, in relation to the aims of the degree program
Apart from storing information and making it available, a central component of modern information systems is, of course, situation-appropriate selection and processing of information. To be able to automate complex, highly-varied processes effectively, an information system must be in a position to react appropriately to unforeseen situations. These lectures teach basic skills in building systems which are able to perceive their environment and are in a position to apply explicitly-represented knowledge to make reasoned decisions.

Learning outcomes
After the classes have finished, the students will be able to

Subject competence
- describe the fundamental concepts and terminology of artificial intelligence (AI)
- select appropriate search strategies to evaluate potential solution options regarding specified quality criteria systematically and efficiently
- describe the syntax and semantics of selected logical languages and to explain different inference mechanisms for the automation of conclusions
- select and apply problem-solving techniques to deal with vague and uncertain information
- design and implement intelligent agents which are able to solve complex tasks independently in selected example scenarios

Method competence
- analyze and model difficult-to-structure problems, and to make efficient solution approaches accessible
- use the agent perspective to analyze existing systems and structure the design of new systems
- understand AI techniques for the explicit representation and processing of knowledge, and to use them to build decision-capable systems
- apply formal languages and conclusion techniques to form theories

Social and personal competence
- recognize and evaluate the limits and risks of implementing these methods in practice
- reflect upon and question the fundamental mechanisms of our own thoughts and actions
- discuss fundamental views of the question: what connects and separates human and machine problem solvers

Content
- Artificial intelligence and rational agents
- Problem-solving through searching
- Problems under boundary conditions and constraints
- Knowledge representation and inference using the example of propositional logic
- Use predicate logic to build logical agents
- Probabilistic reasoning and Bayesian networks
- Aspects of implementing intelligent systems using the example of the aima-java library

Literature references
- Russell, S.; Norvig, P.: Artificial Intelligence – A Modern Approach (Third Edition), Prentice Hall 2010, ISBN-13 978-0136042594
- Beierle, C.; Kern-Isberner, G.: Methoden wissensbasierter Systeme, Vieweg 2006, ISBN-13 978-3834800107

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (1 SWS)

Form of academic assessment			**Monitored assignments**	none
Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.3	**Created**	by R. Lunde on 18.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
AUTSYS	3	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Autonomous Systems *(Autonome Systeme)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Responsible for content	Teaching staff
Prof. Dr. C. Schlegel	Prof. Dr. C. Schlegel

Classification and significance of the course, in relation to the aims of the degree program
In this course, the students will be taught in-depth knowledge about autonomous systems in the context of *embodied intelligence* (e.g. service robots with multimodal interaction possibilities). This includes concepts, methods and algorithms which enable the senso-motoric systems to handle uncertain information in real-world environments robustly, and to equip them with a higher degree of freedom to make decisions.

Learning outcomes
After the classes have finished, the students will be able to

Subject competence
- model uncertain sensor information and use methods for the fusion of uncertain information
- use probabilistic methods for state estimation in new scenarios
- use and adapt localization techniques for acquiring knowledge about the environment and location
- classify implementation approaches for the functionalities of autonomous systems

Method competence
- analyze and model complex problems concerning the handling of uncertain information, and to make efficient solution approaches accessible – especially for questions regarding environmental modeling and acquisition of knowledge about the locality

Social and personal competence
- recognize and evaluate the limits and risks in the practical implementation of these methods
- reflect upon and question the fundamental mechanisms of our own thoughts and actions
- discuss fundamental views of the question: what connects and separates human and machine autonomy

Content
- Advanced algorithms and methods for dealing with uncertain information
  - Probabilistic procedure for state estimation: Kalman filter, particle filter
  - Multi-modal procedures for sensor data fusion, monitoring the surroundings and user interaction
  - Localization techniques and algorithms, simultaneous localization and mapping (SLAM)
- Realization of cognitive architectures and autonomous systems
  - Structuring by means of service-oriented component approaches
- Practical exercises using mobile robots, e.g. Pioneer P3DX platforms

Literature references
- S. Thrun, W. Burgard, D. Fox: Probabilistic Robotics, MIT Press, 2005, ISBN 0-262-20162-3
- R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza: Introduction to Autonomous Mobile Robots, 2nd Edition, Intelligent Robotics and Autonomous Agents series, MIT Press, 2011, ISBN 0-262-01535-8
- D. L. Hall, J. Llinas: Handbook of multisensory data fusion, CRC Press, 2001, ISBN 0-8493-2379-7
- D. Brugali: Software Engineering for Experimental Robotics, STAR series, volume 30, Springer, 2007, ISBN 3-540-68949-4

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (1 SWS), Lab work (1 SWS)		
Form of academic assessment		**Monitored assignments**	none
Prerequisite course			

Course scope	Time present	Self-study	Practical time	Total time
	30 h	60 h	0 h	90 h

Document version	0.3	Created	by CHS on 19.06.2012, 26.04.2019

Module abbreviation	ECTS	Language	Semester	Type	Cycle
AAIS	6	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Module title
Selected Topics of Information Systems *(Ausgewählte Aspekte von Informationssystemen)*

Assigned to curriculum
Master's Information Systems (1st sem.)

Module responsibility	Teaching staff
Prof. Dr. C. Schlegel	All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
The module guides the student towards independent scientific working, as well as deepening subject knowledge according to individual topical interests and preferences in an application area of Information Systems.

Learning outcomes
After completing the module, the students will be able to interpret sophisticated scientific literature and convincingly present and defend complex subjects, both orally and in writing.

Subject competence
- Extended subject expertise by studying selected aspects of Information Systems in greater detail using examples
- Extended analytical expertise through introduction to current topics in research and development
- In-depth cross-subject expertise by combining current topics from research and development with application domains in the field of Information Systems

Method competence
- Working independently to deepen knowledge using sophisticated scientific literature; above all interpreting, questioning, researching, summarizing
- Skills in the writing, publishing and presentation of scientific work

Social and personal competence
- The skills to present complex content convincingly, both orally and in writing
- Critical reflection skills
- The ability to handle one's own and third-party sources and results correctly
- Time management (the balance between the available resources and the achievable quality)

Content
The participants will work independently on a challenging scientific topic, creating a written report and presenting the results. This involves the use of scientific methods and techniques. The topics can complement the project work or explore it in greater detail.
- Basic principles of scientific work as well as scientific work methods
- Literature research – reading, taking excerpts and evaluating scientific literature
- Putting together scientific work and publications
- Rules for quoting, plagiarism, cataloging and administrating scientific work
- Speech and presentation techniques at scientific events
- Working with paper submission systems, for example from EasyChair, as well as creating reviews

Literature references
- Subject-specific information will be given while the currently relevant course is ongoing

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written composition, presentation (30 min)		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.2	Created	by CHS on 19.06.2012, 26.04.2019

Module abbreviation	ECTS	Language	Semester	Type	Cycle
PROJ	12	English	1st and 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Module title
Project Information Systems *(Projekt Informationssysteme)*

Assigned to curriculum
Master's Information Systems (1st sem. / 2nd sem.)

Assigned classes
Project phase 1, Project phase 2

Module responsibility	Teaching staff
Prof. Dr. C. Schlegel	All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
The module is closely related to practice, with a project-related working style which is typical for Computer Science. It permits students to deepen their methodological and subject-specific knowledge according to their preferences and interests, as well as specialization in an application area of Information Systems. Since the module is spread across two semesters, it permits an appropriately broad subject area to be explored, shaped and developed, so that the project work represents the typical phases of team dynamics and technology selection, with the appropriate depth and complexity.

Learning outcomes
At the end of the module, the students will have acquired the methods and tools for realizing complex information systems in a typical project-work environment, and have extended and interlinked specialist knowledge. They will have mastered the methods for solving research-oriented and application-specific problems by means of computer science; particularly regarding the theory and practice of Information Systems and its application areas.

Subject competence
- Analysis and design expertise: to be able to identify and structure problem areas, to develop, substantiate and evaluate solution strategies, and select technologies
- Implementation skills: to be able to implement the selected solutions, as well as developing the in-depth specialist knowledge required for this.
- Technical expertise: to be able to combine knowledge from different areas and apply it in a focused way. To be able to extend, adapt and refine technologies

Method competence
- Getting to grips with a problem by working independently
- Independent development of solutions as well as the associated coordination in the team
- Independent adaptation in the implementation process as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people from different functions and different specialist backgrounds
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies

Content
- Working on a project over two semesters in the field of "Information Systems" in groups of typically 6 people, with the roles distributed as is usual in professional practice
- Experiencing all the phases in the execution of a project, the realistic structure of which is oriented towards experiences from professional practice
- Focus on informatics aspects (design, realization, use) of large, complex, distributed information systems, particularly in the application fields: intelligent systems, medical information systems or commercial information systems
- Using and deepening the subject and methodological knowledge
- A particular feature is that the question is worked on in a project team, with project-specific organization, implementation and planning. The specific content, procedures and methods used depend on the question being considered.

Literature references • Project-specific literature on topical aspects and on procedure models, project management and tools will be given while the currently relevant module is ongoing				
Form of academic assessment	Laboratory work, monitored assignments, presentation (15min)		**Monitored assignments**	Presentation 15min
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	150 h	150 h	360 h

Classes	**SWS**	**ECTS**	**Teaching and learning form**
Project phase 1	2	6	Project work
Project phase 2	2	6	Project work

Document version	0.2	**Created**	by CHS on 19.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
PROJ1	6	English	1st	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Project phase 1 (Project Stage 1)

Assigned to curriculum
Master's Information Systems (1st sem.)

Responsible for content	Teaching staff
Prof. Dr. C. Schlegel	All professors of the degree program

Classification and significance of the course, in relation to the aims of the degree program
(see Module description)

Learning outcomes
(see Module description)
Subject competence
- The focus of Project Phase 1 is on analysis and design skills and technical expertise

Method competence
- Getting to grips with a problem by working independently
- Independent development of solutions as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people from different functions and different specialist backgrounds
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies
- Understanding the significance of non-subject related aspects for the success of the project

Content
In project phase 1 the focus is on
- structuring a project, project management, project phases, milestones, self-organization
- procedure models, development methods, tools, version administration, project documentation
- analysis of the problem and conception of solutions

Literature references
- Project-specific literature on topical aspects and on procedure models (e.g. SCRUM), project management and tools will be given while the currently relevant module is ongoing

Teaching and learning form	Project work		
Form of academic assessment		**Monitored assignments**	Presentation 15min
Prerequisite course			

Course scope	Time present	Self-study	Practical time	Total time
	30 h	75 h	75 h	180 h

Document version	0.3	Created	by CHS on 19.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
PROJ2	6	English	2nd	☑ Compulsory ☐ Elective	☐ Summer semester ☑ Winter semester

Course title
Project phase 2 (Project Stage 2)

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. C. Schlegel	All lecturers

Classification and significance of the course, in relation to the aims of the degree program
(see Module description)

Learning outcomes
(see Module description)
Subject competence
- The focus of Project Phase 2 is on realization and commissioning skills and technical expertise

Method competence
- Independent adaptation in the implementation process as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people from different functions and different specialist backgrounds
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies
- Understanding the significance of non-subject related aspects for the success of the project…

Content
Continuation of PROJ1 with a focus on
- structuring a project, project management, project phases, milestones, self-organization
- procedure models, development methods, tools, version administration, project documentation
- realization and commissioning

Literature references
- Project-specific literature on topical aspects and on procedure models (e.g. SCRUM), project management and tools will be given while the currently relevant module is ongoing

Teaching and learning form	Project work			
Form of academic assessment			**Monitored assignments**	none
Prerequisite course	PROJ1			
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	75 h	75 h	180 h

Document version	0.3	**Created**	by CHS on 19.06.2012, 26.04.2019

Module abbreviation	ECTS	Language	Semester	Type	Cycle
ISEC	6	English	2nd	☑ Compulsory ☐ Elective	☐ Summer semester ☑ Winter semester

Module title
Information Security *(Informationssicherheit)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Module responsibility	Teaching staff
Prof. Dr. M. Schäffter	Prof. Dr. M. Schäffter

Classification and significance of the module, in relation to the aims of the degree program
Information security is essential for distributed information systems, both from the business as well as from the technical perspective. Establishing and ongoing maintaining an appropriate level of security places high demands on the design, development, and integration of information systems. For the degree program, the focus is set on the particular problems in information security for the planning, implementation and evaluation of distributed information systems.

Learning outcomes
After the module has finished, the students will be able to

Subject competence
- explain the main aspects of an Information Security Management System based on ISO 27000,
- describe and treat typical security vulnerabilities in computer networks and web applications,
- apply risk management techniques to identify, assess, and treat risks,

Method competence
- derive concrete security measurements for distributed systems, in particular for web applications,
- deduce and justify specific security recommendations for distributed systems and web applications,

Social and personal competence
- discuss case studies and work out results, and present them in teams.

Content
- Security management: Security goals, threats, vulnerabilities, protective measures, risk identification, assessment and treatment, standards in information security.
- Network security: Typical security vulnerabilities in computer networks, protective measures, including dataflow control (firewalls) and encryption (VPN, https).
- Security in distributed applications: Typical security vulnerabilities in Web applications and databases, example attack patterns, protective measures, including multilayer security, strong authentication, virus protection, sand boxing, encryption.
- Secure coding: Best practice in software development and in testing safety-critical applications.
- Cryptography: Basic cryptographic services as encryption, digital signature, and cryptographic authentication, symmetric and asymmetric encryption methods (AES, RSA, ECC), man-in-the-middle attack, certificates, public key infrastructures.

Literature references
- Computer Security: Principles and Practice. William Stallings and Lawrie Brown. Pearson, 2018; ISBN 978-0135137116
- Cryptography and Network Security: Principles and Practice. William Stallings. Prentice Hall International; 7th revised edition, 2016; ISBN 978-0137056323
- Information Security: Risk Assessment, Management Systems, the ISO/IEC 27001 Standard- Cesare Gallotti. LULU PR, 2019; ISBN 978-0244149550
- Secure Coding: Principles and Practice. Mark M. Graff and Kenneth R. Van Wyk. O'Reilly Media, 2003; ISBN 978-0596002428
- Gray Hat Hacking: The Ethical Hacker's Handbook. Allen Harper et. Al. McGraw-Hill Education Ltd; 5th edition, 2018; ISBN 978-1260108415
- The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws: Discovering and Exploiting Security Flaws. Dafydd Stuttard and Marcus Pinto. John Wiley & Sons, 2nd revised edition, 2011, ISBM-10: 1118026470, ISBN-13: 978-1118026472
- Writing Secure Code. Michael Howard and David LeBlanc. Microsoft Press Book, 2003; ISBN-10: 0735617228, ISBN-13: 978-0735617223

Other literature may be specified as part of the current relevant class.

Teaching and learning form	Lectures (3 SWS), Lab work (1 SWS)			
Form of academic assessment	Written examination		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.4	**Created**	by MS on 12.06.2012, 08.04.2019

Module abbreviation UMAN	ECTS 5	Language German	Semester 2nd	Type ☑ Compulsory ☐ Elective	Cycle ☐ Summer semester ☑ Winter semester

Module title
Business management *(Unternehmensmanagement)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Module responsibility	Teaching staff
Prof. Halder / Prof. Dippe	Prof. Halder / Prof. Dippe

Classification and significance of the module, in relation to the aims of the degree program
General management expertise is essential for graduates of technically-oriented Master's degree programs. Therefore, knowledge of value-oriented business management and planning is absolutely necessary.
Using the method of a management simulation, participants will experience content taught in class through management in a realistic context focusing on competences as flexibility, creativity and communication skills.

Learning outcomes
After finishing the module, the students will be able to

Subject competence
- formulate, identify and analyze the framework conditions and most significant factors influencing the commercial success of companies;
- recognize, critically evaluate and handle complex decision situations in organizations, in the presence of uncertainty;
- develop and apply commercially-oriented, networked thinking and acting in everyday business;
- develop company goals and strategies and specify their implementation in an economical-ecological environment;
- use commercial data for practice-related insights and decisions;

Method competence
- understand and successfully use financial planning tools, balance sheets and income statements, cost and contribution margin calculations, as well as profitability and investment calculations;
- understand the background of ratings according to the Basel II standard and actively carry out business ratings;
- evaluate and develop strategic and operative success factors for organizations.

Social and personal competence
- behave correctly when handling information and make decisions under time pressure and while considering ethical aspects;
- shape the company procedures in a business, both individually and in small groups, and prepare and realize decisions with regard to operative and strategic targets.

Content
The expertise and skills listed will be acquired by studying the following topics:
1. Strategic management at a company level
2. Marketing
3. Accounting
4. Business analysis
5. Finance and forecasting
6. Production and supply chain planning
7. Controlling and cost calculation
8. Leadership and labor relations

In addition to theoretical instruction in the fields mentioned above, a haptic business game and the management simulation GENERALMANAGEMENT from Topsim will be used. During the simulation, the participants take on the role of the "management boards" in teams and lead their respective companies. All companies are in direct competition, mutually influencing each other in a market context, and the participants must take responsibility for their decisions and the results.
During the seminar short pieces of analysis and essays have to be written and special topics have to be presented and will be graded. Additionally, there will be a final written exam as well as an essay/research assignment which has to be written subsequent to the course to reflect the seminar content and apply it to a new field. In order to pass the course each part of the exam has to be passed separately. The final grade will reflect a weighted average of all parts.

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written exam, group work, research assignment, presentations		**Monitored assignments**	Presentations, group works
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	70 h	20 h	150 h

Document version	0.1	**Created**	by AH on 05.06.2019

Module abbreviation VISY	**ECTS** 7	**Language** English	**Semester** 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Module title
Distributed and Interacting Systems *(Verteilte und interagierende Systeme)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Module responsibility	**Teaching staff**
Prof. Dr. S. Traub	Prof. Dr. S. Traub

Classification and significance of the module, in relation to the aims of the degree program
The module provides the necessary fundamentals for creating large information systems. These are also always large distributed systems, so that distributed systems methods form the technical basis when designing and implementing information systems.

Learning outcomes
After the module has finished, the students will be able to
Subject competence
- adapt and apply the basic building blocks and algorithms of a distributed application, such as, for example, logical time, distributed locking and update protocols
- analyze and solve distributed system questions and problems – such as replication, fault tolerance, security and consistency
- be able to use selected middleware systems and web technologies, and use these sufficiently well to implement a distributed information system

Method competence
- analyze a distributed information system, plan a new one and implement it practically

Social and personal competence
- in discussions with others, work out results together and present them

Content
- Introduction and requirements
- Types of communication
- Middleware structures
- Name services
- Synchronization
- Consistency and replication
- Fault tolerance
- Cloud and Web technologies
- Selected topics of current development and research projects.

Literature references
- Distributed Systems: 1. Februar 2017 Maarten van Steen, Andrew S. Tanenbaum
  ISBN-978-1543057386

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (2 SWS)			
Form of academic assessment	Written examination		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	75 h	135 h	0 h	210 h

Document version	1.0	**Created**	by ST on 26.4.2019

Module abbreviation MASAR	**ECTS** 30	**Language** German English	**Semester** 3rd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☑ Winter semester

Module title
Master Thesis

Assigned to curriculum
Master's Information Systems (3rd sem.)

Module responsibility Prof. Dr. C. Schlegel	**Teaching staff** All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
Independent scientific working over a longer period of time

Learning outcomes
To acquire and demonstrate the ability to work on complex problems in the field of Information Systems, by using the acquired knowledge, scientific methods and insights; to carry out the work independently within a specified period of time, at a sophisticated scientific level; to classify the results in subject-specific and cross-subject contexts; to present them in the form of a scientific thesis, and to present and defend the work in front of an expert audience.

Content
The Master's thesis is a theoretical, software-related, empirical and/or experimental thesis, on a topic from the field of Information Systems. The application of a scientific approach and methodology is required in the execution of the work. The student must proceed systematically, analytically and with methodological correctness. The thesis must be argued logically and succinctly; the work must be goal-oriented and time-critical. The results must be presented in the correct form and the student must be able to defend them convincingly. The work generally includes the following phases:

- Analyze the problem and define the topic
- Literature research in scientific sources
- Formulate the investigation approach / procedure
- Select, apply, adapt, develop, implement appropriate scientific procedures and methods
- Analyze the results, critical comparison / evaluation with the state-of-the-art, reflect upon further developments in the considered aspect of Information Systems and their application
- Time and project management
- Clear and academically-appropriate presentation of the results in the form of a scientific piece of work
- Present and defend the results in front of an expert audience

In addition to the scientific thesis, the supervision includes preparation for the final presentation and defense of the thesis.

Literature references
will be provided / independently-researched depending on the topic.

Teaching and learning form	Project work; self-study under guidance (scientific working, preparation of the Master's thesis)		
Form of academic assessment	Written piece of work, the student must hold a presentation and specialist discussion on the thesis topic / defense of the thesis acc. section 21 of the examination regulations	**Monitored assignments**	none

Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	840 h	0 h	900 h

Document version	0.2	**Created**	by CHS on 19.06.2012, 26.04.2019

Electives

Module abbreviation ISWAHL	**ECTS** 6	**Language** English German	**Semester** 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Module title
Subject specific elective module (Specialization and Emphasis)

Assigned to curriculum
Master's Information Systems (2nd sem.)

Assigned classes
Elective subject 1, elective subject 2

Module responsibility Prof. Dr. C. Schlegel	**Teaching staff** (see courses)

Classification and significance of the module, in relation to the aims of the degree program
The module serves to deepen the students' methodological and subject-specific knowledge according to individual preferences and interests, as well as specializing in an application area of Information Systems.

Learning outcomes
- Expertise in advanced fields of computer science and computer science applications, with a focus on Information Systems.

Content
- Two classes are selected from the subject-specific elective module catalog for the Information Systems Master's degree program.

Literature references
- Literature references will be given during the individual courses

Form of academic assessment	Written examination (section 28 of the examination regulations)	**Monitored assignments**	none

Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Example courses	**SWS**	**ECTS**	**Teaching and learning form**
Discrete Event-Based Simulation *(Diskrete Event-basierte Simulation)*	2	3	Lectures (1.5 SWS), Lab work (0.5 SWS)
Ubiquitous Computing	2	3	Lectures (1 SWS), Lab work (1 SWS)
IT Law *(IT-Recht)*	2	3	Lectures (2 SWS)
Electronic medical records *(Elektronische Gesundheitsakten)*	2	3	Lectures (2 SWS)
Predictive Analysis	2	3	Lectures (0.5 SWS), seminars, laboratory work (1.5 SWS)
and more (see section 28 for the specification of subject-specific elective modules by the Faculty)			

Document version	0.3	**Created**	by CHS on 19.06.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
DES	3	English	2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
Discrete Event-Based Simulation *(Diskrete Event-basierte Simulation)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. K. Lunde	Prof. Dr. K. Lunde

Classification and significance of the course, in relation to the aims of the degree program
The simulation of complex systems and the concomitant abstraction and model building are important techniques which occur in diverse applications. In the module, the students model time-discrete processes, such as queue systems and operating systems, using state machines and stochastic distributions, and work with the methods of discrete event-based simulation.

Learning outcomes
After the classes have finished, the students will be able to
Subject competence
- model and simulate deterministic processes with state machines (e.g. in Stateflow)
- model, formally describe (e.g. with UML diagrams) and simulate stochastic processes (e.g. with Desmo-J) in event and process-based perspectives
- use appropriate distributions for data modeling and validate data models as well as simulation results

Method competence
- analyze real processes, identify problem-relevant aspects and suitable modeling approaches
- carry out a simulation project according to the proper methods and critically evaluate the results

Social and personal competence
- work together in small groups to develop potential solutions to theoretical and practical problems

Content
- Modeling: state machines, Markov chains, stochastic distributions
- Method: carrying out a simulation project, data modeling, model validation
- Applications: queueing systems and operating systems

Literature references
- Jerry Banks et al.: *Discrete-Event System Simulation*, 5. Auflage, Pearson New International 2013.
- Averill M. Law: *Simulation Modeling and Analysis*, 5. Auflage, McGraw Hill 2014.
- Anne Angermann et al.: *Matlab, Simulink, Stateflow*, 9. Auflage, De Gruyter 2016.

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (1.5 SWS), Lab work (0.5 SWS)		
Form of academic assessment	Written examination (section 28)	**Monitored assignments**	none
Prerequisite course	none		

Course scope	Time present	Self-study	Practical time	Total time
	30 h	60 h	0 h	90 h

Document version	0.6	Created	by KLu on 15.04.2012, 26.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
ITR	3	German English	2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
IT Law *(IT-Recht)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. M. Schäffter	Prof. Dr. M. Schäffter, Dr. Ph. Kramer (associate lecturer)

Classification and significance of the course, in relation to the aims of the degree program
An understanding of the legal requirements in the field of information technology, software development and Internet law as well as the legal know-how essential for conceiving and developing legally-compliant information systems.

Learning outcomes
After the classes have finished, the students will be able to
Subject competence
- describe the essential legal requirements in the development and operation of information systems,
- draw case-typical judgments from selected case examples,
- use legally drawn-up consulting solutions from real-life practice on typical case examples,

Method competence
- interpret legal statements,
- discuss typical problems from real-life practice from a legal justification perspective,

Social and personal competence
- develop and present solution approaches in cooperation with others.

Content
- Overview of the field of law "IT Law"
- Effects of IT, media and copyright law on computer science
- Contract law in IT: Project contracts, test systems, supplier liability, software maintenance and outsourcing, hosting contracts
- Internet law: Telecommunications law, name and domain protection, e-commerce and online shops
- Computer/copyright and competition law: Software license models, software licensing contracts, Open-Source-Software, Digital Rights Management (DRM), protection of databases
- Data protection requirements: the right of individuals to determine the use of their private data, protection of personal data, limits of data use
- Criminal law: criminal boundaries for IT activities, procedures, product piracy

Literature references
- Computerrecht. Jochen Schneider. dtv Verlagsgesellschaft, 2018; ISBN 978-3423055628
- DSGVO/ BDSG: Datenschutz-Grundverordnung/ Bundesdatenschutzgesetz und Nebengesetze. Martin Eßer (Hrsg.). Verlag Carl Heymanns, 2018; ISBN 978-3452289902
- Handbuch EDV-Recht: IT-Recht mit IT-Vertragsrecht, Datenschutz, Rechtsschutz und E-Business. Jochen Schneider (Hrsg.). Verlag Dr. Otto Schmidt, 2017; ISBN 978-3504560942
- Governing IT Outsourcing Relationships: The roles of contract, control, and relational norms. Daniel Kuhlmann. Diplomica Verlag, 2012; ISBN 978-3842879539
- IT-Projektverträge: Erfolgreiches Management für Auftragnehmer. Christoph Zahrnt. reateSpace Independent Publishing Platform, 2013; ISBN 978-1492844433
- Medienrecht (Start ins Rechtsgebiet). Dieter Dörr und Rolf Schwartmann. Verlag C.F. Müller, 2019; ISBN 978-3811448230
- Praxis des IT-Rechts: Praktische Rechtsfragen der IT-Sicherheit und Internetnutzung. Horst Speichert. Vieweg+Teubner Verlag; 2. Auflage, 2007. ISBN-10: 3834801127, ISBN-13: 978-3834801128
- Praxishandbuch Medien-, IT- und Urheberrecht. Rolf Schwartmann (Hrsg.). Verlag C.F. Müller, 2017; ISBN 978-3811446625

Other literature may be specified.

Teaching and learning form	Lectures (2 SWS)			
Form of academic assessment	Written examination (section 28)		**Monitored assignments**	none
Prerequisite course	none			
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.4	**Created**	by MS on 19.06.2012, 08.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
NAMI	3	English	2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
Navigation for Medical Interventions *(Navigation für medizinische Interventionen)*

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. A. Franz	Prof. Dr. A. Franz

Classification and significance of the course, in relation to the aims of the degree program
Technical assistance systems, including applications of augmented reality (AR) enter our everyday life. Examples are navigation systems for cars and apps for mobile devices that can overlay virtual information to camera images. Medicine can also profit from such new technologies, for example diagnosis and treatment of patients can be improved. The goal of this lecture is to teach students about the basic components for navigation systems in medicine and about the main challenges regarding introduction of such systems into clinical practice.

Learning outcomes
After the classes have finished, the students will be able to

Subject competence
- explain which technologies are required for a medical navigation system
- perform calculations which are necessary for navigation, such as transformation of coordinates and principal component analysis
- enumerate established tracking technologies and discuss their advantages and disadvantages
- explain the operating principle of a navigation systems based on a practical example, such as a system for percutaneous needle insertions
- name and discuss problems with translation of navigation systems to clinical practice

Method competence
- open medical imaging date with a viewer software and visualize it in an appropriate way (e.g., volume visualization of sliced data),
- segment anatomical structures in medical images (e.g., CT images)
- plan a navigated medical intervention on a given example

Social and personal competence
- discuss and rate given concepts in a team
- work on a given problem in a team and present the solution

Content
- Tracking technology for localization of medical instruments
- Medical imaging in the context of further processing to enable navigation during medical interventions
- 3D reconstruction for the localization of anatomical structures
- Methods for planning of medical interventions
- Registration of medical imaging data to an intraoperative scene
- Visualization of imaging and planning data by using virtual and augmented reality
- Software development for navigated medical interventions

Literature references
- F. A. Jolesz (Herausgeber), *Intraoperative Imaging and Image-Guided Therapy*, ISBN 9781461476566, Springer 2014
- Wolfgang Niederlag, Heinz U. Lemke, Gero Strauß, Hubertus Feußner (Herausgeber), *Der digitale Operationssaal*, ISBN 9783110334302, Walter de Gruyter 2014
- T. Peters and K. Cleary (Herausgeber), *Image-Guided Interventions*, ISBN 9780387738581, Springer 2008

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (2 SWS)		
Form of academic assessment	Written examination (section 28)	**Monitored assignments**	none
Prerequisite course	none		

Course scope	Time present	Self-study	Practical time	Total time
	30 h	60 h	0 h	90 h

Document version	0.2	Created	by AF on 03.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
PRANA	3	English	2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
Predictive Analytics

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. R. von Schwerin	Prof. Dr. R. von Schwerin, Prof. Dr. Volker Herbort

Classification and significance of the course, in relation to the aims of the degree program
Predictive Analytics is an important part of the growing field of Data Science. Working on a predictive analytics task usually follows the well-known CRISP-DM process, starting with Business understanding up to deployment. After deployment, the results may be used both in operative as well as analytic information systems. From a methodical point of view, the most important aspects are data engineering, the application of suitable methods for data profiling, feature engineering and finally the use of appropriate machine learning and visualization methods.

Learning outcomes
After the classes have finished, the students will be able to

Subject competence
- classify analytical problems in an overall context (e.g. business case)
- work on and solve analytical problems acc. to CRISP-DM (e.g. using *Jupyter Notebooks*)
- use suitable (machine learning) methods for the problem and validate the analysis results
- demonstrate the added value of the analysis results found, in the overall context

Method competence
- analyze real analytical tasks, identify problem-relevant aspects and suitable data sources
- prepare data in a fashion suited to the machine learning algorithm to be applied, e.g. GeoData
- carry out an analysis project according to the proper methods and critically evaluate the results
- present the results using appropriate visualizations

Social and personal competence
- work together in small groups to develop solution approaches for practical problems and present these convincingly

Content
- Key terminology: multidimensional data, data mining, machine learning, open data
- (Open Source) software for analytics, in particular Python and Jupyter Notebooks
- Method: carry out an analysis project, proceed as per CRISP-DM
- Basic methods of Machine Learning

Literature references
- Trevor Hastie et al.: *The Elements of Statistical Learning*, 2nd ed., Springer, 2009.
- Ian H. Witten and Eibe Frank: *Data Mining*, 4th ed., Elsevier, 2016
- Matthew A. Russell.: *Mining the Social Web*, 3rd ed., O'Reilly, 2019.
- Sebastian Raschka: *Python Machine Learning*, 2nd ed., Packt Publishing

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (0.5 SWS), seminars & laboratory work (1.5 SWS)		
Form of academic assessment	Coursework, Final Quiz	**Monitored assignments**	rolling
Prerequisite course	none		

Course scope	Time present	Self-study	Practical time	Total time
	30 h	60 h	0 h	90 h

Document version	1.0	Created	by RvS on 27.04.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
UBCMP	3	English	2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
Ubiquitous Computing

Assigned to curriculum
Master's Information Systems (2nd sem.)

Responsible for content	Teaching staff
Prof. Dr. F. Steiper	Prof. Dr. F. Steiper

Classification and significance of the course, in relation to the aims of the degree program
The miniaturization of processors, sensors and wireless modules is leading to increasing integration and interlinking of information technology in everyday objects. On this basis, new types of information systems – adapted to their situation and available everywhere – are created which do not require explicit user interaction. This module provides an understanding of the particular challenges, technologies and methods for realizing these kinds of information systems.

Learning outcomes
After the classes have finished, the students will be able to

Subject competence
- describe the fundamental properties and paradigms of ubiquitous systems
- explain the technical fundamentals of ubiquitous computing

Method competence
- assess technologies, methods and algorithms for different application areas of Ubiquitous Computing and evaluate their suitability
- develop and implement concepts for ubiquitous, context-processing applications

Social and personal competence
- present their own solution approaches in a small team and defend the results of their work

Content
- Overview of the concepts of Ubiquitous Computing
- Technological basics of ubiquitous systems:
  Wireless communication techniques; mobile sensors; identification, positioning and tracking technologies
- Methods and algorithms for distributed data processing and fusion in sensor networks
- Human-computer interfaces
- Context, situation and activity detection methods
- Small projects with mobile devices (e.g. android based mobile phones), wireless sensor nodes and depth-sensing cameras

Literature references
- Joseph J. LaViola et al.: *3D User Interfaces: Theory and Practice*, Addison Wesley (2017), ISBN 978-0134034324
- Dominique D. Guinard, Vlad M. Trifa: *Building the web of things*, Manning Publications Co. (2016), ISBN 978-1617292682
- Stefan Poslad: *Ubiquitous Computing – Smart Devices, Environments and Interactions*, John Wiley & Sons (2009), ISBN 978-0470035603
- Feng Zhao, Leonadis J. Gubias: *Wireless Sensor Networks, An Information Processing Approach*, Morgan Kaufmann Publishers Inc. (2004), ISBN-13: 978-1558609143

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (1 SWS), Lab work (1 SWS)		
Form of academic assessment	Oral examination	**Monitored assignments**	none
Prerequisite course	none		

Course scope	Time present	Self-study	Practical time	Total time
	30 h	60 h	0 h	90 h

Document version	0.3	Created	by FS on 01.05.2012, 29.04.2019